



Experimental evidence for interpretive but not attention biases towards somatic information in patients with chronic fatigue syndrome

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Objective. This study tested whether CFS patients have an attentional information processing bias for illness-related information and a tendency to interpret ambiguous information in a somatic fashion.

Design. 25 patients meeting research criteria for a diagnosis of CFS were compared to 24 healthy matched controls on a modified Stroop task and an ambiguous cues task.

Method. In the modified Stroop task, participants colour named a series of somatic, depressed and neutral words in order to ascertain whether the somatic words were more distracting to the CFS patients than the depressed and neutral words when compared to controls. In the ambiguous cues task, participants were presented with a tape-recorded list of 30 words including 15 ambiguous illness words (e.g., vein/vain) and 15 unambiguous words. For each word, they were asked to write down the first word that came into their head. A somatic bias score was obtained for each subject by summing the number of somatic responses to the ambiguous word cues.

Results. Although CFS patients were significantly slower in colour naming all of the Stroop word categories than controls, there was no evidence for illness or depressed words creating greater interference than neutral words. However, on the ambiguous cues task, CFS patients made significantly more somatic interpretations than controls and this bias was significantly associated with the extent to which they currently reported symptoms.

Conclusion. CFS patients have an interpretive bias for somatic information which may play a part in the maintenance of the disorder by heightening patients' experience of physical symptoms and helping to maintain their negative illness schemas. Although patients did not show an attentional bias in this study, this may be related to the methodology employed.

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Chronic fatigue syndrome (CFS) is an illness characterized by persistent debilitating fatigue of uncertain origin. CFS has a profound disabling effect on people's lives, with around 40% unemployed because of their illness and a further 20–30% having to substantially reduce their work commitments (Bombardier & Buchwald, 1995, 1996; Lloyd, Hickie, Boughton, Spencer, & Wakefield, 1990). The prognosis is often poor. A recent systematic review reported that when left untreated, fewer than 10% of adults with CFS return to their premorbid levels of functioning (Joyce, Hotopf, & Wessely, 1997). Although the causes of the illness are still debated by researchers, cognitive behavioural models of the illness have been developed which suggest that CFS is caused by a complex interaction of factors (Surawy, Hackmann, Hawton, & Sharpe, 1995; Wessely, Butler, Chalder, & David, 1991). These models propose that patients' illness beliefs are key factors in the perpetuation of the condition.

There is growing evidence to support this proposition. Most CFS patients believe that their illness is predominantly caused by physical factors (Moss-Morris & Petrie, 2001; Powell, Dolan, & Wessely, 1990; Vercoulen *et al.*, 1996; Weinman, Petrie, Moss-Morris, & Horne, 1996) and this belief is associated with ongoing symptoms and higher levels of disability over time (Cope, David, Pelosi, & Mann, 1994; Sharpe, Hawton, Seagroatt, & Pasvol, 1992; Wilson *et al.*, 1994).

CFS patients also tend to view their illness in a more negative light than other patient groups. They attribute a wider range of symptoms to their disorder, are less likely to believe that their own behaviour is related to their illness and perceive their illness to have more serious consequences when compared to patients with illnesses such as diabetes, rheumatoid arthritis and major depression (Moss-Morris & Petrie, 2001; Weinman *et al.*, 1996). These negative illness beliefs have been associated with increased disability and psychological distress in CFS (Heijmans, 1998; Moss-Morris & Petrie, 2001; Moss-Morris, Petrie, & Weinman, 1996; Petrie, Moss-Morris, & Weinman, 1995).

A limitation of the CFS cognitive studies to date is that they have relied exclusively on self-report measures. Not only are self-reports open to response bias, but they assume that patients are able to readily access or acknowledge their underlying cognitions. Self-reports also tell us little about the dynamic thought processes which lead to the development and maintenance of these beliefs. Cognitive theories of disorders such as depression and anxiety, suggest that maladaptive schemas or beliefs can bias the processing of information through attentional, interpretive and memory processes, which in turn help to maintain the pathogenic schemas (Beck, 1991; Ingram, 1990). There is considerable empirical support for the hypothesis that each disorder has its own unique or specific pathogenic cognitions (MacLeod & Mathews, 1991; Mathews & MacLeod, 1994).

In a recent self-report study, we compared CFS patients' cognitions with those of depressed patients (Moss-Morris & Petrie, 2001). The depressed group was distinguished by a low self-esteem, the propensity to make cognitive distortions across all situations, and to attribute their illness to psychological factors. In contrast, the CFS patients were characterized by low ratings of their current health status, a belief that a large number of symptoms were related to their illness, external attributions for their CFS, and distortions in thinking that were specific to somatic experiences. We wanted to extend these findings to ascertain whether these self-reported cognitive structures affect the way in which these patients process information. In particular, we wanted to determine whether CFS patients' tendency to view themselves as seriously ill people

may lead them to focus unduly on somatic information and to interpret ambiguous information in a somatic fashion.

To investigate this we adapted laboratory paradigms which have been used to investigate information processing biases in chronic pain patients. Chronic pain is the extent of the disability reported by patients is often disproportional to the physical findings and pain specific cognitions appear to be important in maintaining the disorder (Turk, 1999). Attentional biases in chronic pain have been investigated using an adapted Stroop task. Participants are presented emotionally salient words as distracters, which they must attempt to ignore while performing a colour naming task. A preliminary study found that when compared to healthy controls, chronic pain patients were more susceptible to interference from pain-related stimuli, but not depressed or affect-related stimuli (Pearce & Morley, 1989). A more recent study failed to replicate these findings (Pincus, Fraser, & Pearce, 1998). Mood, rather than pain, was found to influence response latencies to the pain stimuli. Clearly, more research is needed to clarify the role of the somatic condition versus concurrent mood in influencing the attentional bias.

The findings from studies which have investigated interpretive biases for pain-related information have been more consistent. Using an ambiguous word-stem completion task, Edwards and Pearce (1994) established that chronic pain patients produced significantly more pain-related word completions than both healthy controls and health professionals. Similarly, when asked to produce spontaneous associations to ambiguous word cues, such as 'terminal' and 'growth', chronic pain patients made significantly more health-related associations than controls and health professionals (Pincus, Pearce, McClelland, Farley, & Vogel, 1994). Finally, when presented with a list of homophones followed by a free-recall task, pain patients made significantly more negative health-related interpretations than controls (Pincus, Pearce, & Perrot, 1996). These results were independent of mood disturbance, but correlated highly with self-reported pain.

The current study used a modified Stroop task and an ambiguous word cue task to investigate information processing biases in CFS patients. Because CFS is associated with a wide range of somatic complaints (Moss-Morris, 1997; Ray, Weir, Cullen, & Phillips, 1992), the tasks included a range of symptom and illness-related information, rather than pain-specific information. We hypothesized that CFS patients, when compared to healthy controls, would show an attentional bias for somatic rather than neutral or depressed stimuli on the Stroop task, and a tendency to interpret information in a somatic fashion on the ambiguous cues task. We also hypothesized that these information processing biases would be positively correlated with CFS patients' somatic symptom reports, but unrelated to their reports of depression and anxiety.

Method

Participants

CFS group

The CFS patients were recruited from a general medical practice specializing in the treatment of CFS. A total of 53 patients aged between 18 and 65 years who were diagnosed with CFS using the Fukuda *et al.* (1994) criteria in the past year, were

approached to participate in the study. The response rate was 57% with 30 participants returning consent forms. Of these, four did not meet current research criteria for CFS and one pulled out of the study on the basis that she was not well enough to come to the laboratory. The mean length of illness for this group was 11.25 years ($SD= 8.75$). Eight of these patients were unable to work at all because of their illness and seven had to reduce their work commitments to part time.

Healthy controls

The 24 healthy controls were recruited from the University of Auckland and the community on the basis that they matched the demographic characteristics of the CFS group. Participants were required to have no history of CFS, and no current symptomatic chronic illness. Table 1 shows that the groups were matched for age, gender, years of education and verbal intelligence using the National Adult Reading Test (NART) (Nelson & Willison, 1991).

Table 1. Characteristics of the groups participating in the study: means (SDs)

	CFS N = 25	Healthy controls N = 24	Value
Gender (% women)	88%	87.5%	$\chi^2 = 0.171, p = .68$
Age	47.72 (11.79)	46.17 (11.60)	$t(47) = 0.47, p = .64$
Years of education	13.78 (2.78)	14.26 (2.69)	$t(44) = -0.59, p = .56$
NART scores	14.76 (6.69)	13.55 (6.72)	$t(47) = 0.67, p = .51$
Negative affect	12.56 (3.55)	10.96 (1.52)	$z = -1.78, p = .08$
Positive affect	26.32 (7.71)	26.00 (8.11)	$t(47) = 0.14, p = .89$
Somatic checklist	22.56 (6.08)	13.79 (2.70)	$t(33.43) = 6.57, p < .001$
HAD anxiety	7.63 (3.89)	5.21 (3.16)	$t(46) = 2.36, p < 0.05$
HAD depression	7.21 (2.38)	2.38 (2.59)	$t(46) = 5.54, p < .001$
PFRS (CFS symptoms)	118.09 (30.09)	19.29 (15.26)	$t(35.89) = 14.58, p < .001$

Measures

The Hospital Anxiety and Depression Inventory (HAD; Zigmond & Snaith, 1983)

The HAD was used as a measure of anxiety and depression as both these mood states have been shown to influence information processing (Mathews & MacLeod, 1994). The HAD consists of two 7-item subscales and is a well-validated measure of anxiety and depression in medically ill patients (Clark, Cook, & Snow, 1998). It has also been recommended for use in CFS populations, as somatic symptoms which may overlap with this illness are excluded from the scale (Ray, 1991).

The two-dimensional Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988)

The PANAS was used to determine participants' current mood. The Positive Affect (PA) scale measures the degree to which a person feels enthusiastic, active and alert, while the Negative Affect (NA) dimension assesses subjective distress and discomfort. The scales have high internal consistency and are largely uncorrelated (Watson *et al.*, 1988)

In this study, participants were asked to indicate to what extent they were experiencing each emotion 'right now'. This is in contrast to the HAD, which asks people to answer each question in relation to the past week. Thus, the PANAS can provide a measure of current mood fluctuation which may not necessarily be associated with anxiety or depression. Subtle alterations in mood states have also been shown to affect biases in information processing.

The Profile of Fatigue-Related Symptoms (PFRS; Ray et al., 1992)

The PFRS was included as a measure of CFS-related symptoms. It was developed specifically for CFS patients and measures their reports of fatigue, somatic symptoms, cognitive difficulty and emotional distress. In order to be able to separate the effects of emotional distress from the experience of somatic symptoms, only the first three subscales were used to provide a composite score of symptom reports. The PFRS has high internal reliability and good test-retest reliability over a 1-month period (Ray *et al.*, 1992). The Cronbach alpha for the composite score in this study was .98.

The somatic checklist

This is an expanded version of a scale originally developed by Pennebaker (1982) and modified by Wood, Bental, Gopfert, Dewey, & Edwards (1994) to measure CFS patients' somatic responses to laboratory-induced stress. Participants were asked whether or not they were currently experiencing sensations such as 'rapid heart beat', 'dizziness' and 'ringing in the ears'. The somatic checklist therefore provides an indication of somatic preoccupation or awareness. For ease of administration, the severities of the 11 physical sensations were rated on the same 5-point scale as the PANAS. The Cronbach alpha for this adapted scale was .83.

The National Adult Reading Test (Nelson & Willison, 1991)

The NART is a test of verbal intelligence which is generally unaffected by illness or cognitive impairment. It was included in this study to verify that the groups were matched for intelligence, as it has high reliability and validity and is easy to administer (Nelson & Willison, 1991). It is standardized for participants between 20 and 70 years of age and requires minimal effort and concentration from the participants.

The NART is composed of a list of 50 words presented in order of increasing difficulty. None of the word follows the regular rules of English pronunciation, so that reading relies heavily on word recognition rather than phonemic translation. The participants are asked to read the list of words aloud in the order that they are presented. Mistakes are recorded by the experimenter and a total error score is computed at the end of the test.

Modified CFS Stroop task

A modified CFS Stroop task was developed to determine whether somatic relevant words were more distracting to CFS patients than depressed relevant words. The words for the task were selected by asking six independent clinical experts to rate, on a 5-point scale, how relevant 47 words were to depression and CFS. The words were drawn from previous studies using adaptive Stroop tasks in depression (Gotlib & McCann, 1984; Williams & Broadbent, 1986) and from interview data with CFS patients. A total of 10

words with high mean scores on the CFS scale but low scores on the depressed scale were selected for the somatic Stroop task, while words with the opposite pattern of scores were selected for the depressed task (see Table 2). Each of these 20 words was matched for Thorndike-Lorge (Thorndike & Lorge, 1944) frequency and length with a neutral word.

Table 2. Health professionals' mean ratings of experimental words selected for the CFS Stroop task and their matched neutral words

Somatic words (<i>M</i> ; <i>SD</i> for the CFS rating)	Matched somatic neutral words	Depressed words (<i>M</i> ; <i>SD</i> for depressed rating)	Matched depressed neutral words
disease (3.8; 1.1)	lighted	hopeless (4.7; 0.5)	applause
collapse (4.2; 0.5)	balances	tormented (4.4; 0.6)	cornstalk
sick (4.0; 0.7)	cake	grief (4.5; 0.5)	rides
fatigue (4.8; 0.4)	lasting	gloomy (4.6; 0.5)	casual
fever (3.4; 1.5)	beads	sorrow (4.4; 0.6)	accent
infection (3.6; 1.7)	imitation	dismal (4.2; 0.5)	gamble
nausea (3.2; 0.8)	sonata	terrible (3.8; 0.8)	somewhat
breathless (3.5; 0.9)	ceremonies	failure (4.6; 0.6)	develop
dizzy (3.3; 0.5)	dingy	tortured (4.1; 0.6)	computed
aches (3.6; 1.1)	tinkle	lonely (4.1; 0.2)	patrol

Four experimental tasks were created for the somatic, depressed and two groups of neutral words based on the methodology employed by Pearce and Morley (1989) in their study of chronic pain. The tasks were presented on white A4 card and comprised two columns of 25 word stimuli. Each stimulus was written in letters 5mm high in one of five colours; red, blue, green, yellow and brown. The colours were randomly dispersed with the constraints that each colour was used five times in each column, each word was repeated five times, and that the two attributes of the stimulus (colour and word) were never placed in succession. A simple colour-naming practice card was also created using the same format, but the words were replaced with groups of five Os. Participants were asked to name the colours in which the stimuli were written as fast and as accurately as possible and to correct any errors. The five sheets were placed face down in front of the participant, who was asked to turn them over when the experimenter said 'go'. The time taken for each card was recorded with a stop-watch. To control for a possible practice or fatigue effect, the tasks were presented in random order across participants, except for the practice sheet which was always presented first.

Ambiguous cues task

Based on an activity conducted with chronic pain patients (Pincus *et al.*, 1994), a list of 30 words was created to assess whether CFS patients have an interpretative bias for somatic or illness-related information. Of these, 15 were ambiguous words (e.g., weak/week, growth, vein/vain) which were randomly interspersed among 15 unambiguous words (e.g., fish, house, telephone). The ambiguous words had both neutral and illness-related interpretations or connotations, six of which were drawn from the chronic pain study (Pincus *et al.*, 1994). The activity was presented as a word association exercise

where participants were asked to write down the first word that came into their heads after one of the stimulus words had been read out to them.

Responses were initially coded by the experimenter as neutral or illness-related and cross checked by an independent rater who was blind to participant group. There was a 100% agreement of the rating structure. A summary of the illness-related responses versus neutral responses to the ambiguous words is presented in the Appendix. Participants scored one for every illness-related interpretation so that the maximum somatic bias score was 15.

Procedure

Participants completed the HAD and PFRS the night before the laboratory tasks. On arriving in the laboratory, they completed the PANAS and the somatic checklist so that their current mood state could be assessed. Testing began with the NART, which was used to determine whether the groups were matched for intelligence. The presentation sequence of information processing tasks was the same across participants, beginning with the modified Stroop task and followed by the ambiguous cues task. Participants were debriefed at the end of the testing and offered the opportunity to contact the investigator if they were interested in their test results.

Results

Self-report measures

All data analyses were conducted on SPSS version 10. Exploratory analysis of the mood and symptom variables showed that they generally met the assumptions of normality with the exception of NA, which showed a substantial positive skew. Logarithmic and square root transformations of this variable failed to improve the distribution, so the Mann-Whitney *U* test was used to assess group differences on this variable and Spearman's rho was used in correlational analyses. Independent Samples *t* tests were conducted on the remaining variables. In cases where the Levene's test for equality of variances was significant, the standard errors of the equations were adjusted accordingly.

The results of these analyses are presented in Table 1. This table shows that there were no significant differences between the groups on their reports of state NA and PA, although the scores on the NA scale did approach significance, suggesting that the CFS patients were feeling somewhat more distressed than the healthy controls. The difference on the HAD anxiety scale was significant, although this difference was not as large as the difference on the HAD depression scale. The largest discrepancy between the groups was on the PFRS total score and the somatic checklist, implying that the CFS group reported substantially more symptoms than the control group and that they were also more focused on their current somatic sensations.

Ambiguous cues task

The ambiguous cues task generated a single somatic bias variable which measured the number of somatic interpretations participants made in response to ambiguous word cues. In support of the study's hypothesis, an independent samples *t* test showed that the CFS group ($M = 5.16, SD = 1.77$) made significantly more somatic interpretations than the healthy control group ($M = 3.42, SD = 1.44$), $t(47) = 3.77, p < .001$. Because the

point biserial correlation between depression and participant group was $r = .63$, we were unable to use depression as a covariate to rule out the possibility that depressed mood was responsible for these findings. Consequently we used the recommended cut-off of a score of eight on the HAD depression scale (Zigmond & Snaith, 1983) to remove CFS patients who might have a concurrent diagnosis of depression from a second between-group analysis of the somatic bias scores. In all, 11 CFS patients and one control participant were removed from this second analysis, but the pattern of results remained the same, $t(35) = 3.80$, $p < .001$.

Correlations were computed to investigate the relationships between the somatic bias score and the demographic, mood and symptom variables (see Table 3). Age and verbal intelligence appeared to be unrelated to the tendency to make somatic interpretations. Rather, somatic interpretations were significantly positively correlated with the somatic checklist and the PFRS, and to a lesser extent to the HAD depression scale. Current mood state and anxiety appeared to have no affect on the somatic bias score. Partial correlations showed that the relationship between the somatic bias score and the somatic checklist remained significant even when holding depression scores constant, $r(49) = .46$, $p < .001$. However, the correlation between somatic biases and depression disappeared when controlling for the somatic checklist, $r(49) = .05$, $p = .75$.

Table 3. Correlations between the somatic bias score, time taken to colour name the modified Stroop stimuli and the demographic factors, mood and symptom scales ($N = 49$)

	Somatic bias score	Somatic words	Matched somatic neutral words	Depressed words	Matched depressed neutral words
Age	.11	.29*	.30*	.33*	.28*
NART scores	-.13	.02	.06	.02	.06
Negative affect	.18	-.06	.08	-.04	.07
Positive affect	.11	.14	.04	.21	.13
Somatic checklist	.55**	.28	.41**	.43**	.31*
HAD depression	.33*	.37*	.49**	.43**	.35*
HAD anxiety	.03	.12	.43**	.34**	.33*
PFRS (CFS symptoms)	.43**	.37*	.54**	.51**	.38**

* $p < .05$; ** $p < .01$.

We also investigated these relationships just within the CFS group. Only the association between the somatic bias score and the somatic checklist remained significant, $r(25) = .41$, $p < .05$. This correlation was unaltered when partialling out the effects of both depression and current NA. To determine whether chronicity of the illness could influence the tendency to interpret information in a somatic fashion, we correlated the somatic bias score with length of illness. This correlation was not significant, $r(24) = .21$, $p < .33$.

Modified CFS Stroop task

The Stroop data were made up of two sets of variables: the somatic stimuli with their matched control words and the depressed stimuli with their matched control words.

The mean times taken for each group to name the sets of stimuli are presented graphically in Fig. 1. An interference index was calculated from these mean scores by subtracting the time taken to name the matched neutral words from the time taken to name the depressed and somatic stimuli. These indices provided a measure of how much more interference participants experienced when colour naming emotional or somatic stimuli compared to neutral stimuli. To test the hypothesis that CFS patients would experience significantly greater somatic interference rather than depressed interference when compared to controls, the depressed and somatic interference indices were entered into a 2 (group) \times 2 (interference index) ANOVA. Using Wilk's criterion, there was neither a significant main effect, $F(1,45) = .66, p = .42$, nor a significant interaction between group and interference, $F(1,45) = .95, p = .14$. These results suggest that, contrary to the study's hypothesis, somatic stimuli were no more distracting to CFS patients than depressed stimuli and there were no differences between the groups in this regard.

Although the nature of the stimuli did not seem to have an effect on CFS patients' information processing, Fig. 1 suggests that they were slower in colour naming in general when compared to controls. A MANOVA with group as the fixed factor and the four Stroop stimuli types as the dependent variables confirmed that the CFS group was significantly slower in colour naming, $F(4,42) = 3.64, p < .01$. The univariate tests showed that this difference was significant for each of the stimuli regardless of content. To investigate whether mood or symptom variables were contributing to the slowness in colour naming, correlations were computed between the Stroop stimuli and the mood variables. Table 3 shows that age, depression, anxiety and symptom reports all correlated with increased colour naming times.

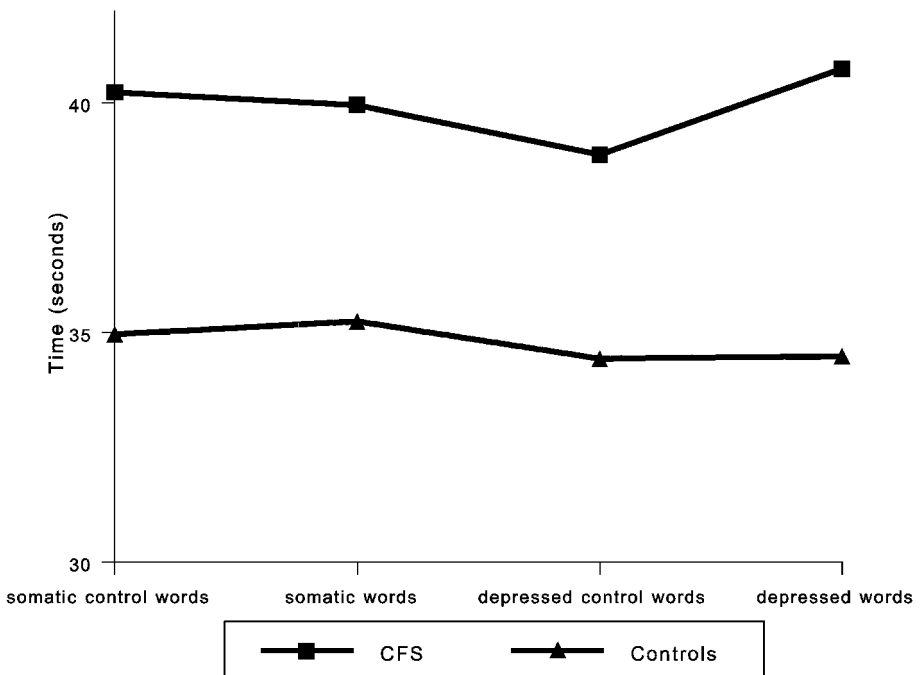


Figure 1. Time taken to colour name the modified Stroop stimulus material in the healthy control and CFS groups.

Discussion

The results from this study suggest that CFS patients have an interpretive but not an attentional information processing bias for somatic information. When presented with equivocal information, CFS patients tended to interpret this information in a somatic or illness-related manner when compared to healthy controls. This finding is consistent with chronic pain studies which have found that these patients demonstrate biases for pain-related information across a number of laboratory methodologies (Edwards & Pearce, 1994; Pincus *et al.*, 1994, 1996). The data are also consistent with self-report studies which have shown that CFS patients tend to interpret symptoms in a catastrophic or over-generalized fashion (Moss-Morris & Petrie, 2001; Petrie *et al.*, 1995).

CFS patients' somatic bias scores were associated with the extent to which they currently reported or focused on symptoms. This relationship was independent of both level of depression and current NA, suggesting that the interpretive bias in CFS is not just a function of negative affect or concurrent depression. Similarly, self-report data have shown that the presence of concurrent depression does not affect CFS patients' tendency to make somatic cognitive distortions (Moss-Morris & Petrie, 2001). Self-reported somatic cognitive distortions in CFS are also more closely related to symptom reports and level of disability than self-esteem and depression (Moss-Morris & Petrie, 1997).

The finding that CFS patients have an interpretive bias for somatic information is consistent with both schema theory (Beck, 1991) and cognitive behavioural models of CFS (Surawy *et al.*, 1995). Previous work has shown that CFS patients have a particularly negative schema of their illness and a fixed belief that their illness is largely physical in nature (Moss-Morris & Petrie, 2001; Weinman *et al.*, 1996). This schema may act as a filter for illness-related information which results in the experience of symptoms being amplified beyond the sum of the sensory components. Consequently, as demonstrated in this study, the somatic interpretive bias may lead to the ongoing experience of unpleasant symptoms. In turn, the experience of symptoms helps to maintain the negative illness schema.

These findings also provide support for the use of cognitive therapy for CFS. A key component of current cognitive therapy approaches to CFS involves identifying and challenging CFS patients' negative interpretations of their symptoms (Chalder, 1995). This process has been shown to lessen the extent to which patients experience their symptoms, and to increase their functional capacity (Reid, Chalder, Cleare, Hotopf, & Wessely, 2000).

In contrast to the ambiguous cues findings, the adapted Stroop results did not support the study's hypotheses. When compared to controls, CFS patients did not appear to have an attentional bias for illness-related information. A similar pattern of results has occurred in the literature on chronic pain, where the memory and interpretive biases for emotionally salient information appear to be more robust than the attentional bias for such information (Pincus & Morley, 2001). However, it is premature to conclude that CFS patients do not have an attention bias for somatic stimuli as there may be important reasons for these null findings. On a fundamental level, words may be inappropriate stimuli to test for an attention bias for somatic stimuli (Pincus & Morley, 2001). Paradigms which test for attentional effects using actual physical sensations or stimuli may better reflect patients' attention to their physical state. There is some evidence from exercise studies showing that this may indeed be the

case. CFS patients consistently overestimate their amount of effort on exercise tasks which may reflect their tendency to focus on their discomfort (Fry & Martin, 1996). It may also be that the attentional bias in CFS is only evident under certain conditions. For instance, people who report a heightened fear of pain have shown an attentional bias toward pain-related information, while those with a low fear of pain have not (Keogh, Ellery, Hunt, & Hannent, 2001). About a third of CFS patients have demonstrated an exaggerated or heightened fear response to effort, and it may be that this subgroup has a particular attention bias for somatic information (Petrie *et al.*, 1995).

Although CFS patients did not demonstrate an interference effect on the Stroop task they were significantly slower than the healthy controls to colour name regardless of the content of the stimuli. These results are consistent with neuropsychological studies of CFS patients which have used the conventional Stroop colour naming task (Moss-Morris, Petrie, Large, & Kydd, 1996; Wearden & Appleby, 1996). In the current study, the time taken to colour name the Stroop stimuli was positively correlated with anxiety, depression and symptom reports. These results suggest that although somatic stimuli do not appear to be more distracting to CFS patients than other stimuli, mood and symptom factors may contribute to their difficulty in screening out all potentially distracting information.

Certain constraints of this study need to be noted. Because it is a cross-sectional study, it is limited by the possibility that CFS patients' somatic interpretive bias may be a reflection of having a chronic physical illness, rather than a factor which contributes to the ongoing experience of symptoms. Longitudinal studies, and studies comparing CFS patients to patients with other physical illnesses, particularly ones with high levels of disability, would help to address this possibility. However, it is worth noting that while most of the CFS patients included in this study had been ill for quite some time, length of illness, unlike reports of general somatic complaints, was not significantly related to somatic biases. Another possible limitation is the mode of Stroop presentation. We used cards which rely on an experimenter to manually operate a stop-watch, rather than a computer-generated Stroop which automatically times the participants' response. The choice of cards over a computer was made as some CFS patients believe that they have a negative reaction to computer radiation. It is possible that our results may have been influenced by experimenter error, although a review of Stroop studies in the pain area showed that the mode of Stroop presentation did not seem to influence the results of the studies (Pincus & Morley, 2001).

Despite the limitations, the results from this study demonstrate that the information processing methodologies devised to assess cognitions in psychological disorders and pain can be usefully applied to CFS. These methods provide a way of assessing cognitive concerns without relying on self-report measures. The results from the current study suggest that these methodologies provide additional support for the cognitive model of CFS. More sophisticated methodologies could be developed for future studies. These include computerized versions of the Stroop task which measure reaction time for each individual word and the lexical priming paradigm which controls for the possibility of response bias when measuring interpretive effects.

Acknowledgements

This research was supported by the Health Research Council of New Zealand.

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Received 18 May 2001; revised version received 2 January 2002

Appendix: Summary of the illness-related and neutral responses to the ambiguous word cues

Ambiguous cues	Illness-related responses	Neutral responses
vein/vain	blood, artery, graft, medical	proud, pretty, mirror, lady
consumption	illness, sickness, TB, dying	food, eat, chocolate, use
vital	energy, signs, health, organs	necessary, essential, important
sensitive	flesh, weak, sore, tender	touch, cry, calm, feather
head	ache, pain, sore, hurt	hair, eyes, hat, nod
palpate	indigestion, throb, heart, doctor	massage, feel, touch, press
growth	tumour, hormone, cancer, lump	child, tall, improvement, chart
chemical	sensitivity, brain, toxic, disease	reaction, substance, compound
drain	energy, tired, low	sink, dirty, clean, smell
weak/week	nausea, exhausted, sore, sick	day, month, calendar, small
wrench	pain, tear, socket, gut	take, grasp, spanner, nut
relief	pain, ache, aspirin, rest	pleasure, glad, joy, laugh
mercury	thermometer, temperature, poison, blood	silver, flow, bottle, planet
bed	tire, tired, rest, sleepy	pillow, make, duvet, cosy
exhaust	fatigue, collapse, illness, sleep	car, smell, rusty, pipe